Messin' in the Mud*

Time
one 45-minute session

Vocabulary
Cesium 137, erosion**,** floodplain, pollutant**,** radio-isotope, sediment, sedimentation, water quality, watershed

Objectives
Students will be able to:

- ☐ determine how sediment samples are gathered.
- ☐ determine how sedimentation rate values are calculated.

Method
Students graph and interpret actual Mississippi River data of sediment accumulations and perform an activity looking at sedimentation in a stream/river/pond.

Materials
graph paper
smooth, clear plastic water bottle or container
Table 1

Background
At the time of Zebulon Pike's Mississippi River expedition, the North American fur trade was underway. Euro-Americans had been traveling the Mississippi's tributaries trading with Native Americans for many years. Iowa's first Euro-American settler, Julien Dubuque, mined lead with Mesquakie Indians near present day Dubuque for 17 years. Besides the occasional settlement, the Mississippi River had changed little from when Marquette and Joliet had first seen it, 132 years prior to Pike's expedition.

Only 128 years after Pike's journey, people began to construct locks and dams on the Mississippi. The purpose of the locks and dams was to create a series of pools to provide adequate depth for navigation. These pools act like a stair step of water between Minneapolis, Minnesota and St. Louis, Missouri. Construction of the locks and dams permanently flooded lowland **floodplains** (land near a stream/river which flood water spills onto) and transformed seasonal wetlands into large pools of water.

The stabilization of water levels also reduced its rate of flow (speed), hence its ability to transport **sediment** (fine soil and other particles that settle to the bottom of a liquid). The decrease in water speed has accelerated **sedimentation** (accumulation of sediment) along the river. Sediment is now one of the most damaging **pollutants** (substances that may contaminate air, water, or soil) in the river. The constant **erosion** (removal or wearing away of soil or rock by water, wind, or other forces or processes) of upland areas in its **watershed** (land that drains into a particular body of water) threatens to fill in backwaters of the Mississippi within the next 50 to 100 years. So, monitoring sedimentation in the river corridor is very important.

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* Adapted with permission from Exploration of the Mississippi River Activity Guide, Jeff Janvrin, Wisconsin Department of Natural Resources, Wisconsin, 2002.

One way to determine sedimentation rates is to obtain bottom samples from the river and determine the depth at which the **radio-isotope Cesium 137** (^{137}Cs) appears. A radio isotope is a radioactive isotope (one of two or more species of atoms of the same chemical element that have the same atomic number and occupy the same position in the periodic table and are nearly identical in chemical behavior, but differ in atomic mass or mass number and so behave differently in the mass spectrograph, radioactive transformations, and physical properties). ^{137}Cs is a radioactive product of explosions from nuclear bomb tests.

Nuclear fallout first entered our environment in 1954. Peak nuclear testing by Americans occurred during 1957 and 1958. Heavy Russian testing occurred from 1962-1964. In 1971, the French and Chinese engaged in some limited nuclear testing. ^{137}Cs binds strongly to small particles such as clay and organic matter, so tends to retain its position in the soil column. As soil erodes, some particles that have ^{137}Cs bonded to them are deposited downstream as sediment. Provided that sediment is undisturbed, and that the sediment regularly erodes, the amount of sediment deposited during a given time period can be determined by the amount of ^{137}Cs present in that layer of river sediment.

Sedimentation rates have decreased in recent years, but are still a threat to the Upper Mississippi River valley. Some backwater lakes will become marshes within the next century. Since much of the Upper Mississippi River watershed is cultivated, maximum conservation of upland soils is crucial to maintaining the Upper Mississippi River.

To learn more about Zebulon Pike's journey up the Mississippi River, refer to *Iowa's Water,* page 3.

Procedure

1. Share and discuss the *background information* regarding the history of the Mississippi River and how construction of the locks and other factors has contributed to accelerated sedimentation in the Mississippi.
2. Describe to students how ^{137}Cs is used to determine sedimentation rates in the Mississippi River.
3. Provide students with the sedimentation rates data from *Table 1*. Have them graph "pool number" (x-axis) versus "sedimentation rate" (y-axis) for the 1954-64 and 1965-75 time blocks. Students should include a legend with their graph.
4. Have students generate possible explanations for differences in the amounts of deposited sediment for the different pools as well as the different time blocks (i.e., quantities of suspended sediments increase as you go downstream, levees in the upper river prevent erosion, farmland contributes to greater degrees of erosion).
5. Have students speculate on the reasons behind the decreased sedimentation rates in more recent years (i.e., soil loss reduction techniques such as contouring, grassed waterways, conservation tillage).

Evaluation

1. How has the Mississippi River changed since Zebulon Pike explored the area?
2. Where does ^{137}Cs in the environment come from?
3. How is ^{137}Cs used to determine sedimentation rates?
4. List three things (human induced or natural) that contribute sediments to the Mississippi River.
5. How does sediment impact Mississippi River habitats and critters?
6. What are some ways to reduce the amount of sediment that reaches the Mississippi River?

Extensions

Remove the top and bottom of a smooth, clear plastic water bottle or container to form an eight-inch (or longer) "tube." In a wadable stream, push the tube gently into the bottom with a slight twisting motion. When you have pushed the tube in as far as you can, dig down to the bottom of the tube and lift it out of the water. Wipe any mud off the outside of the tube. You should be able to see layers of sediment that have been deposited over time. This is similar to how core samples are done to calculate sedimentation rates.

Research information about soil erosion and conservation in Iowa. Visit the NRCS web site (www.nrcs.usda.gov/technical/land) to view maps on soil erosion rates and learn about factors affecting **water quality** (condition of water).

Go to the photo gallery on the NRCS' home page (www.nrcs.usda.gov) to look at examples of good soil conservation techniques – buffers, contour farming, etc. How many techniques are used in your county?

Teacher Aids

Posters

"Aquatic Life." Ill. Brian Wignall. 1989. Des Moines: Iowa Department of Natural Resources' Aquatic Education Program.

"Benthic Macroinvertebrates." Ill. SB Lauterbach. Des Moines: Iowa Department of Natural Resources' Aquatic Education Program.

"Life in a Stream." Ill. Brian Wignall. 1989. Des Moines: Iowa Department of Natural Resources' Aquatic Education Program.

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"Biodiversity of Iowa: Aquatic Habitats." 2001. Des Moines: Iowa Department of Natural Resources' Aquatic Education Program.

"Canaries of the Deep, The Plight of the Fresh Water Mussel." 2003. Geode Resource Conservation and Development Incorporated.

Books

Iowa Department of Natural Resources. 1987. Iowa Fish and Fishing. Des Moines.

Zim, H.C. and A.C. Martin. 1987. A Golden Guide to Pond Life. New York: Golden Press.

Figure 1: Example of a sediment core using Cesium 137 to determine sedimentation rates

The diagram shows the bottom of the first peak (1954) at approximately 50 cm. Cesium 137 was absent prior to 1954, so, in this area of the Mississippi River, the maximum depth of the bottom of the first peak would be 50 cm.

The bottom of the second peak (1963) is at 18 cm., this represents the second of two main peaks (1954-58 and 1963-64). This suggests the bottom line of the first peak occurred in 1954, and the bottom line of the second peak occurred in 1963. If we consider these to be inclusive years, we can say that 32 cm of sediment accumulated over this 10-year time period.

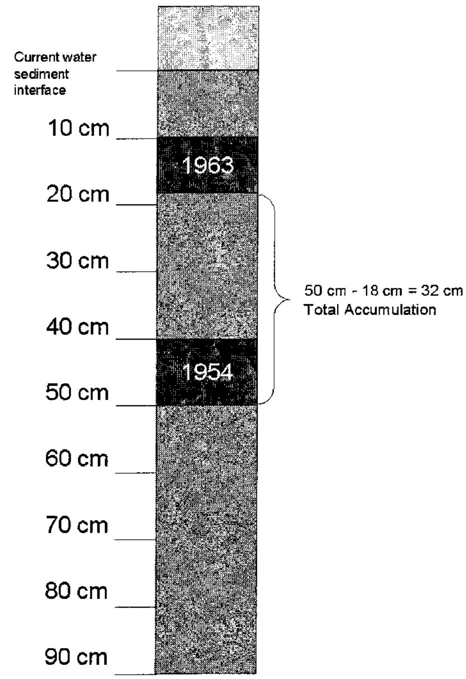

Table 1: Comparison of selected sedimentation rates for Pools 4 through 10, Upper Mississippi River

Pool	Principal Tributary Stream	Number of Profiles Sampled	Maximum Depth 137Cs (cm)	Estimated Rate of Sedimentation (cm/yr) 1954-64 1965-75 (Average Values)
4	Chippewa	5	60	3.4 1.2
5	Zumbro	5	60	3.1 1.1
5A	(None)	4	70	4.1 2.0
6	Trempealeau	6	90	3.0 3.3
7	Black	7	60	3.2 0.9
8	Root	6	80	2.8 2.0
9	Upper Iowa	8	70	4.3 1.2
10	Wisconsin	6	90	3.6 2.5
			Mean	3.4 1.8

Source: Wiener, James G., Richard V. Anderson, and David R. McConville. (ed.) 1984. Contaminants in the Upper Mississippi River. Boston: Butterworth Publisher.